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Research Paper

Assessing the epidemiological data of *Staphylococcus aureus* food poisoning occurred in the State of Rio Grande do Sul, Southern Brazil

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Abstract

Staphylococcal food poisoning is one of the most frequent foodborne illnesses worldwide and it is caused by the ingestion of food contaminated with enterotoxins produced by some strains of *Staphylococcus* (S.) *aureus*. In the State of Rio Grande do Sul (RS), Southern Brazil, *S. aureus* has been identified as the second most frequent agent of foodborne illnesses in the last two decades. The aim of the present study was to assess and analyse the epidemiological data of *S. aureus* food poisoning occurred in the State of RS during the years of 2000 to 2002. The official records of epidemiological investigations carried out by the Sanitary Surveillance Services of the State of RS were analysed. Among foodborne outbreaks for which aetiology was determined, *S.* aureus was identified as the responsible agent of 57 foodborne outbreaks, being 42 (74%) confirmed by microbiological analyses and 15 (26%) confirmed by clinical symptoms and/or epidemiological data. Staphylococcal outbreaks were responsible for the exposition of 5,991 persons, of which 1,940 (32%) were interviewed by the Sanitary Surveillance officers. The most affected age group corresponded to people with 20 to 49 years old (48%), where men (48%) and women (52%) were affected similarly. The main involved food vehicles were meats servings (35%), followed by pastries (25%), cheese (23%), pasta (11%) and potato salad with homemade mayonnaise (11%). The majority of the outbreaks occurred inside private homes (33%) followed by commercial food establishments (28%). Inadequate control of temperature and failures in general hygiene practices were identified as the main factors responsible for the outbreaks. In conclusion, *S. aureus* was an important food poisoning etiological agent in the State of RS during 2000 to 2002 and its prevention depends on control measures involving different parts of the food chain.

Key words: *Staphylococcus aureus*, food poisoning, RS State, Brazil.

Introduction

S. aureus is a leading cause of diverse infections in humans, including gastroenteritis. Staphylococcal food poisoning occurs due to the ingestion of enterotoxins preformed in food, and its symptoms include vomiting, diarrehea and cramps. This illness is one of the most prevalent foodborne disease worldwide (Atanassova *et al.*, 2001; Cunha and Cunha; 2007; Pigott, 2008) and in Brazil *S. aureus* was identified as the second most important foodborne pathogen during the period of 1999 to 2011 (Carmo *et al.*, 2008; Brasil, 2011). From 1987 to 1992, the official reports of the Secretary of Health of the State of RS identified *S. aureus* as the main etiological agent of foodborne illnesses in RS (CEVS, 2005; 2006). After this period up to the present, *Salmonella* assumed the first place as the most important etiological agent for foodborne outbreaks in the State of RS followed by *S. aureus*. In the State of Paraná, other State of southern region of Brazil, during the period of 1978 to 2000, *S. aureus* was responsible for 41% of the investigated foodborne outbreaks, while *Salmonella* spp. was

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responsible for 34% of the reported outbreaks (Amson *et al.*, 2006).

The *S. aureus* multiplication and enterotoxin production occurs after the exposure of foods to temperatures above 10 °C (Korpysa *et al.*, 2005; Cunha *et al.*, 2006). Currently, approximately 20 types of staphyloccocal enterotoxins are identified (Kishimoto *et al.*, 2004; Huong *et al.*, 2010), being enterotoxins A (SEA) and D (SED) those most involved with staphylococcal food poisoining. These enterotoxins are highly heat stable ($D_{98.9}$ °C= > 2 hours) and also resistant to proteolytic enzymes (Forsythe, 2010).

Even though several emergent food pathogens have been identified worldwide in the last years, *S. aureus* food poisoning remains an expressive social problem, causing frequent outbreaks and financial losses. In the US during 1997, it was estimated that U$ 1, 5 billion were spent due to *S. aureus* food poisoning (CEVS, 2006). A few decades ago this agent was responsible for 25% of all foodborne outbreaks occurred in the US (Su and Wong, 1997).

According to Food and Drug Administration (FDA) (FDA, 2007), the main foods incriminated in staphylococcal food poisoning are meat and meat products, poultry and eggs, egg salads, tuna fish, chicken, cream pies, potatoes, pasta, sauces, cream-filled pastries, chocolate eclairs, sandwiches fillings, milk and dairy products. Also according to the FDA, *S. aureus* can be found in air, dust, sewage, water, milk, utensils used in food preparation, animals and humans.

The investigation of foodborne illnesses is a very complex activitiy, which generally involves several steps. The most common steps are the following: 1) notification of the outbreaks, 2) inspection "in loco" of the involved food establishments, 3) localization and interview of the involved people, 4) sampling and analyses of the suspected foods and/or clinical samples, 5) analyses of the data collected, 6) elaboration and publication of final reports (Almeida *et al.*, 2008). The coordination and execution of all those activities are not easily carried out, resulting in subnotification of the foodborne outbreaks and lack of recorded information about the outbreaks (Welker *et al.*, 2010). In the State of RS the official epidemiological investigations of foodborne diseases are carried out by the coordinated work of the Sector of Epidemiological Surveillance and the Division of Sanitary Surveillance, both sectors of the Centre of Surveillance of Health of the State of RS (CEVS/RS). The epidemiological investigation also counts with the collaboration of the sanitary officers from the 496 municipalities of the State of RS.

Epidemiological foodborne information has great value because it may be used to stablish regional or national control measures, define food safety priorities, set up food control strategies and also to conduct risk analysis studies. In order to make it feasible, such information must be analysed and available to the regulation body officers, scientific community, food industries, consumers and other stakeholders of the food chain.

Based on these facts, the present study aimed to assess and analyse the official records of foodborne illnesses caused by *S. aureus* in the State of RS, during the period of 2000 to 2002.

Materials and Methods

Data on foodborne illness outbreaks caused by *S. aureus* were collected from the official worksheets containing raw data of epidemiological investigation of foodborne outbreaks occurred in the State of RS during the period of 2000 to 2002.

These official data were stored with restricted access in the Center for Surveillance of Health of the State of RS (CEVS/RS), below the custody of the Sector of Epidemiological Surveillance. The records were compiled and analysed by the Food Surveillance Service officers and by the personnel of the Laboratory of Microbiology and Food Control of the Universidade Federal do Rio Grande do Sul (ICTA/UFRGS).

The analysis of the records comprised the following aspects: 1) laboratory tests performed in suspect foods, 2) clinical and epidemiological investigation of the staphylococcal outbreaks, 3) characteristics of the affected population, 4) local of food preparation and consumption, 5) storage conditions of the involved foods and 6) the season of the year in which the outbreaks occurred.

Results and Discussion

Considering the 57 staphylococcal food poinsoning outbreaks registered in the State of RS during the period analysed, 42 (74%) were confirmed by microbiological tests and 15 (26%) were confirmed by clinical symptoms of the victims an/or epidemiological investigations. Among the outbreaks confirmed by laboratorial analysis, *S. aureus* was isolated in 93% of the suspected foods, in 10% of the stool samples and in 10% of the food handler hands. In some outbreaks, *S. aureus* were found simultaneously in food and stool samples and/or hands, affecting the percentages showed above (sum of percentages are bigger than 100%). In 15 other food poisoning outbreaks, the *S. aureus* was not found in samples analysed in laboratories, but was confirmed as the etiological agent through the analysis of the symptoms observed - vomiting, nausea and abdominal cramping - and/or epidemiological information, for exemple, incubation time less than 6 hours.

Although the confirmation of the *S. aureus* toxicity should be done by the investigation of the enterotoxins in foods, this is not carry out routinely in the official Laboratory of the State of RS (FEPPS/LACEN/RS). The suspected foods are anaysed only by classical microbiological methods and the results of the analyses are compared with

parameters set up by the Brazilian microbiological standards for foods (RDC12/2001- ANVISA) (Brasil, 2011).

The Staphylococcal outbreaks comprised 5,991 exposed persons and 1,940 (32%) of them were interviewed by Sanitary Surveillance officers. Among the people interviewed, 1,222 (63%) were confirmed as real patients and 333 (27%) (Figure 1) were hospitalized. No deaths were recorded.

The affected age groups corresponded to the following intervals: 1 to 4 years old (5%), 5 to 9 years old (7%), 10 to 19 years old (20%), 20 to 49 years old (48%) and more than 50 years old (20%). Comparing the distribution of age groups of real patients involved in the outbreaks (Figure 2) with the demographic distribution of the population of the State of RS in 2002 (Figure 3) it was possible to observe that staphylococcal outbreaks did not affected a specific age group of RS population. The distribution between men and women affected in the outbreaks were 48% and 52%, respectively, and these numbers of men and women also coincides with the demographic distribution of general population of RS.

The private homes were the places of food preparation mostly involved in the outbreaks (33%), followed by commercial food establishments (food services, 28%) (Table 1). It is important to note that the same food may have been consumed in more than one place due to the distribution of the involved food.

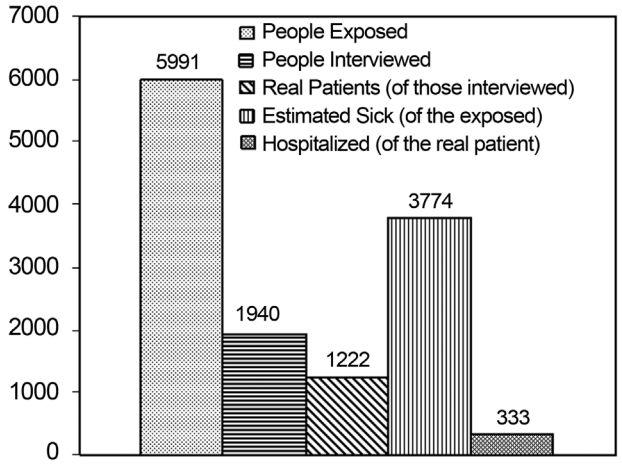

Figure 1 - Numbers of people involved in foodborne outbreaks caused by *S. aureus* occurred in the State of Rio Grande do Sul, from 2000 to 2002.

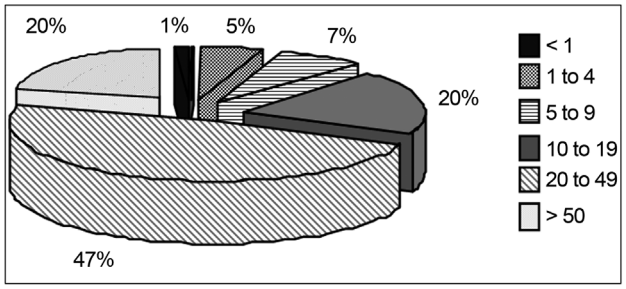

Figure 2 - Age groups (years) of victims of foodborne outbreaks caused by *Staphylococcus aureus* in the State of Rio Grande Sul, during 2000 and 2002.

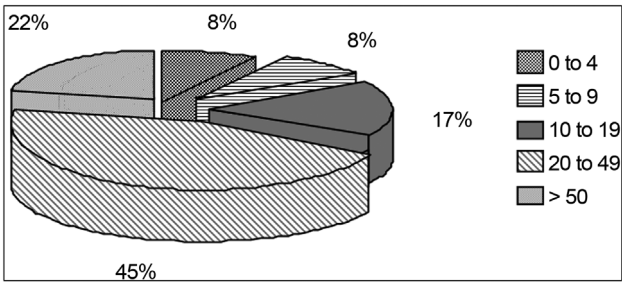

Figure 3 - Age groups of general population of the State of Rio Grande do Sul in 2002.

Similar results have been demonstrated in previous studies which identified the private homes and commercial food stablishments as the main sites involved in salmonellosis occurred in the State of RS (Costalunga and Tondo, 2002; Silveira and Tondo, 2006). For example, Costalunga and Tondo (2002) have reported that 43.7% of the salmonellosis of the State of RS occurred inside home and 25.21% in food services between 1997 and 1999. After that, during 2000 to 2001, the percentage of salmonellosis that occurred inside home increased to 61.5%, while those occurred in food services decreased to 13.7% (Silveira and Tondo, 2006). These data are in agreement with data concerning the whole Brazil between 2000 and 2011 (Brasil, 2011). Results show that the main place of food preparation involved in the total foodborne outbreaks were private homes (44.3%) followed by food services (23.6%) (Brasil, 2011).

The main causal factors responsible for *S. aureus* food poisoning were the storage of food at room temperature for more than 2 hours (27%), the usage of raw materials without inspection (26%) and the inadequate temperature of food storage (8%).

Table 1 - Place of preparation of the foods involved in foodborne outbreaks caused by *S. aureus* occurred in the State of Rio Grande do Sul from 2000 to 2002.

Local	Number of outbreaks	(%)
Residence (private homes)	19	33
Commercial food stablishments (food services)	16	28
School kindergarten and nursing home	4	7
Community hall church or gymnasium	4	7
Industry	4	7
Clubs and associations	3	5
Industrial kitchen	3	5
Other	4	7
Total	57	100%

Table 2 - Causal factors of foodborne outbreaks caused by *S. aureus* occurred in the State of Rio Grande do Sul from 2000 to 2002.

Causal factors	Number of outbreaks	(%)
Storage in improper cooling	9	8
Inadequate storage in hot temperature	3	3
Improper cooking	2	2
Reheating inappropriate	1	1
Storage at room temperature for more than 2 h	32	27
Cross-contamination	11	9
Contamination with toxic chemicals	0	0
Use of toxic utensils	0	0
Ingestion of contaminated water	3	3
Infected food handlers	4	3
Poor hygiene of equipment and utensils	8	7
Improper handling	7	6
Use of raw material without sanitary inspection	30	26
Unknown	7	6
Total	117	100%

Considering the following causal factors together, *i. e.* the storage of food at room temperature for more than 2 hours, storage of food in inadequate cooling, storage of food in inadequate heat, improper cooking and inappropriate reheating of food, it is possible to observe that 41% of the staphylococcal outbreaks were caused by inadequate temperature control (Table 2). Results also demonstrated that 26% of the outbreaks occurred due to the use of raw materials without inspection, mainly meat and eggs, indicating that this kind of food should be considered important sources of microbiological hazards for the public health.

Other interesting result was that the sum of items related to general hygiene, *i. e.* cross contamination, poor hygiene of equipment and utensils; infected food handler and improper handling were responsible for 25% of the outbreaks. These causal factors are basic items of Good Manufacturing Practices Programs (GMP) and the failures identified on that resulting in outbreaks were some of the reasons for the creation of a Brazilian GMP Regulation named RDC 216 in 2004 (Brasil, 2004) and a Regional GMP Regulation called Portaria 78 in 2009 in the State of RS (Secretaria da Saúde, 2009).

According to the reports analysed, diverse types of food preparation were consumed by the victims involved in the staphylococcal outbreaks. 71 food types were registered and their involvement confirmed by laboratory analyses. These foods were preliminarily classified into 7 groups, *i. e.* 1) pastries, 2) potato salad with homemade mayonnaise, 4) preparations containing cheese, 5) meat servings, 6) candy and 7) other kinds of prepared foods (ex. sandwiches, pies, seafood). The higher incidence of food involved in staphylococcal outbreaks was the following: 1) meat servings (35%), 2) candy (25%) and 3) preparations containing cheese (23%). Pires *et al.* (2012) have studied several outbreaks occurred in different countries and reported that dairy products were the most important source of *S. aureus* illness (30.3%), followed by grains and beans (12.9%), meat (10.5%) and other sources (7.0%).

In Japan, the number of food poisoning cases due to *S. aureus* is trending lower because of factors such as improvements in personal hygiene management and improved facilities and equipment. However, large-scale incidents of food poisoning arising from contaminated processed milk occurred during the year 2000, affecting 14,780 people (Anonymous, 2008).

December and January were the months of higher incidences of staphylococcal outbreaks, coinciding with the summer period in the State of RS. Also it was recorded a reasonable incidence of outbreaks in March, April and June, and these occurrances were attributed to traditional popular festivities, as Easter and São João festivities.

The results of this study showed that *S. aureus* was an important cause of foodborne outbreaks in RS State during the period from 2000 to 2002. The results also demonstrated that the most important control measures to prevent Staphylococcal foodborne illnesses were the control of temperature, general hygiene procedures and the use of inspected raw materials. The implementation of these control measures depend on actions involving diverse parts of food chain, accordingly, being necessary the collaboration of the consumers, food producers, universities and Sanitary Surveillance services.

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